

AN ACCOUNT OF
SOME FIELD OBSERVATIONS ON
THE DEVELOPMENT OF
POTATO BLIGHT.

BY F. T. BROOKS, M.A.

[*Re-printed from THE NEW PHYTOLOGIST, Vol. XVIII, Nos. 5 & 6,*
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[WITH TWO FIGURES IN THE TEXT]

Introduction.

EVER since the fungus *Phytophthora infestans* first became the subject of scientific investigation, there has been a good deal of obscurity as to the way in which it is carried over from year to year. The conidia are short-lived and therefore do not serve to tide the fungus over the winter.

In spite of prolonged search, de Bary¹ failed to find resting oospores in diseased potato plants, the fungus in this respect being unlike many other species of *Phytophthora*. He was of the opinion, therefore, that potato blight was carried over from year to year by means of mycelium hibernating in partly diseased tubers, and he obtained definite evidence that mycelium of this kind sometimes passed from the tubers into young shoots, on which the fungus developed its spores above ground, thus forming starting points for an epidemic.

In 1875, Worthington Smith² reported the discovery of resting oospores of the blight fungus in tissues of diseased potato plants, but the evidence was not conclusive and, in the absence of confirmation by other observers, there has always been doubt whether these bodies really belonged to *Phytophthora infestans*.

With the discovery in America by Jones³ and Clinton⁴ that *Phytophthora infestans* developed oospores in pure culture, attention was again directed to the possibility of infection arising from such resting bodies during the early summer, and Pethybridge⁵ followed up this line of enquiry in Ireland. Although he confirmed the development of oospores in culture, he failed to find them in diseased plants. In connection with this work, Pethybridge put to the test the view that the fungus is carried over the winter by mycelium in partly diseased tubers, and, obtained some experimental evidence that, when planted in pots chiefly under greenhouse conditions, a very small percentage of blighted tubers functioned in this way, the great majority either giving rise to perfectly healthy

¹ de Bary, A. Researches into the nature of the potato-fungus—*Phytophthora infestans*. Journ. Roy. Agric. Soc. England, 1876, pp. 239-269.

² Smith, W. G. The resting spores of the potato disease. Gardeners Chronicle, 1875, p. 35.

³ Jones, L. R. Resting spores of the potato fungus. Science, 1909, p. 813.

⁴ Clinton, G. P. Oospores of potato blight. Conn. Agric. Exp. Stat Rept. 1909-10, p. 753.

⁵ Pethybridge, G. H. Investigations on potato diseases. 5th., 6th., 7th., Reports, 1914-6. Journ. Irish Bd. Agric.

tubers or decaying completely in the soil. Under field conditions however, none of the blighted tubers planted experimentally by him were seen to throw up shoots invaded by mycelium of *Phytophthora infestans* derived from the seed sets. In the light of these investigations, the blight problem has also been discussed by Horne.¹

Melhus² in America obtained a considerable amount of evidence in favour of the view that primary infection arises from mycelium which hibernates in the seed tubers. Thus a number of partly diseased tubers planted experimentally in the open threw up one or more shoots which were infected by *Phytophthora* and served as starting points for an epidemic.

In connection with the perennation of potato blight by means of mycelium in diseased tubers, mention may be made of the possibility of shoots becoming infected while the tubers are stored in clamps or after being discarded from these and left lying near them. Such shoots may give rise to spores in the late spring or early summer under favourable weather conditions, and these may serve to infect growing crops close at hand, although there is no published evidence of the occurrence of an outbreak arising in this way.

Portions of blighted tubers left in the soil from the previous crops or introduced with the manure (e.g., from pigs) may also, perhaps give rise to conidia of *Phytophthora* when lying near the surface of the soil, but such diseased tissues usually become invaded by secondary organisms which cause complete disintegration.

There are of course other ways in which the blight fungus might hibernate. Its mycelium may perhaps live saprophytically in the soil but this is unlikely for *Phytophthora infestans* is by no means an easy fungus to grow artificially and in competition with other organisms would probably soon collapse. The intervention of an alternate host has sometimes been invoked but there is no evidence that such exists, and other plants e.g., tomatoes, which occasionally become infected by *Phytophthora infestans* in this country, are only attacked after an epidemic has begun in potatoes. Massee³ considered that the mycelium hibernating in the tubers passed thence into the growing shoots, remaining dormant in the stems and leaves until weather conditions suitable for the sporulation of the fungus intervened, but no evidence in support of the dormancy of the mycelium in the aerial parts of the plants was given. Recently, Eriksson has advanced his mycoplasma theory

¹ Horne, A. S. Potato diseases. Ann. App. Biol., 1914.

² Melhus, I. E. Hibernation of *Phytophthora infestans* in the Irish potato. Journ. Agric. Res., 1915, V, p. 71.

³ Massee, G. Diseases of Cultivated Plants and Trees, 1910, p. 123.

in explanation of the rapid onset of epidemics of potato blight, but without any evidence more critical than has hitherto been brought forward in his other papers on mycoplasma; it is obvious that the possibility of explaining the propagation of potato blight from year to year by the agency of mycoplasma will stand or fall by the mycoplasma theory in general, which, it may be said, is still entirely unproven.

Nearly all the work on the means of over-wintering of potato blight referred to above, has been done on a small scale under experimental conditions, and few careful observations have been made in the field as to the way in which the fungus first develops in potato fields planted under ordinary conditions. On account of the uncertainty still existing as to the means by which the earliest appearance of blight in epidemic form in the growing crop is brought about, Dr. A. S. Horne and the writer decided to carry out observations in certain parts of the country with a view to throwing further light on this matter, if possible. It was clear that the districts chosen for these observations should be areas in which the fungus develops in epidemic form, as it were endemically, *i.e.*, without infection by spores brought by air currents from other quarters. Consideration of the progress of the epidemic of potato blight in 1917 shewed that the Penzance district and the Isle of Wight fulfilled this requirement, for in that year *Phytophthora* developed in both these areas before it appeared in the adjacent parts. Although the observations around Penzance were the first to be taken, those made in the Isle of Wight will first be described, as operations there were conducted in greater detail and with better facilities. In the original program, it was arranged that the writer should make observations in the Penzance district, and that Dr. Horne should do the same in the Isle of Wight, but after making some preliminary visits to the island, the latter was unfortunately prevented by illness from continuing the work, the direction of which then devolved upon Professor F. W. Oliver and the writer.

Observations in the Isle of Wight.

Through the financial assistance of the Food Production Department, and the kind interest of Mr. Lawrence Weaver, C.B.E. (Food Production Department) and of Professor F. W. Oliver, F.R.S., certain members of the staff and students of University College, London, including Misses E. Goodyear, E. A. Fraser, M. L. Hett, M. Munro, E. J. Whitehead, B. Russell Wells, M. A. Sutton, H. S. Pearson, H. A. Bond, A. Gotlieb, together with Mr. H. Stansfield of the Imperial College, and Miss Osborn and Miss Barker of Bedford College, spent several weeks in the island during

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June, July, and August, examining potato fields in detail, under the general direction of Professor Oliver and the writer, the latter being then Plant Pathologist to the Food Production Department of the Board of Agriculture. As the exigencies of the war prevented the continued presence of the same observers throughout this period, continuity was maintained by relays of workers. •

The plan of operations was as follows:

The observers were divided into three groups stationed in different parts of the island. At each centre two series of observations were carried out;

(a) By rapid examination of a considerable number of potato fields scattered in the neighbourhood.

(b) By intensive inspection of each individual plant in small plots.

If any of the plots under rapid survey became suspiciously affected, it was the intention to place them under detailed observation. Plots of early and second early varieties were usually chosen for this work as it is well known that these are usually affected by blight before the later varieties.

The mode of procedure in the detailed inspection was as follows:—each plant was minutely examined, as far as possible from day to day, and any discolouration in the haulm that came under suspicion of being an early stage in the development of blight was noted, and the plant marked for further observation. Sometimes the affected part was removed and incubated under conditions suitable for the development of *Phytophthora* and then examined microscopically in a room near the plots, temporarily used as a laboratory. Dark patches on the stem and lower leaves were the symptoms especially looked for.

Unfortunately two of the centres had to be closed before *Phytophthora* appeared and it is not worth while to describe the negative evidence alone obtained at these centres. At the third centre the potato fields under rapid observation gave only negative results but *Phytophthora* appeared in two of the plots under detailed examination and a summary account of these results will now be given. Many of the following notes are based upon observations made by Mr. H. Stansfield by whom also the plans of the plots were drawn.

PLOT 1.

This plot, situated at Haven Street, contained about 130 plants of the second-early variety, White Beauty of Hebron, grown from own-saved seed. In 1917 the crop was onions and two years previously the ground was a fowl run. All these plants were of

vigorous growth. The position of the plants particularly noted is hewn on the accompanying plan (Fig. 1).

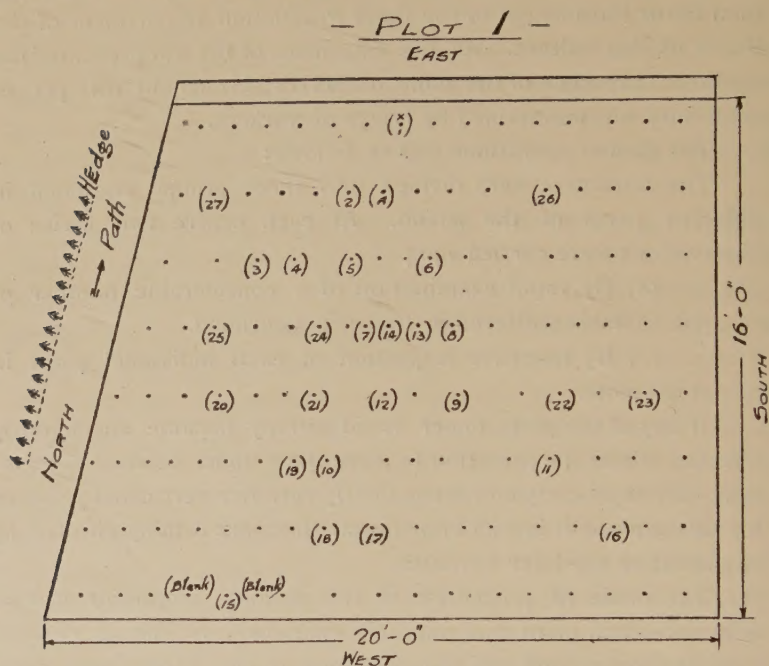


Fig. 1. Plan of Plot 1.

The record of the observations on Plot 1 is as follows:—

June 25. A plant, subsequently called plant A, shewed three separate brownish-black zones on one of the two main stems arising from the parent tubers. These discoloured areas extended about two inches upwards from one and a half inches above soil level and were suspected of being affected by *Phytophthora*. Careful search in the vicinity, however, failed to reveal any shoot bearing spores which might have been the source of infection.

A portion of one of these discoloured areas was removed for microscopic examination, but by the time (July 1) it reached the writer in London, bacterial decomposition was so advanced as to prevent the certain diagnosis of *Phytophthora* although spores similar to those of blight were found on the surface. It was therefore probably affected by blight.

On the same day two of the lower petioles were seen to be partly withered.

On this date no similar discolouration was seen in any other plant in this plot.

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As regards the previous weather conditions, rain fell on June 21st and 24th.

June 30. One of the lower petioles of plant A part of which shewed a brownish discolouration, was placed in a collecting tube and despatched to London where it developed spores of *Phytophthora infestans* freely by July 3rd on the discoloured parts, thus shewing that this petiole had been affected by the blight fungus.

July 4. There was no change in plant A. Other plants were as before.

July 6. The brownish-black zones on one of the main stems of plant A had spread considerably.

July 7. Another stem of plant A arising as a lateral from the main stem already mentioned, shewed discolouration all round at about the same distance above soil level and extending upwards about two inches. This black zone was not in continuity with the discoloured areas noted on June 25th.

The plant A was now dug up and a second smaller main stem arising from the old tuber was found healthy throughout. On the main stem which shewed discoloured areas above ground no blackening was found below soil level, but three tubers were diseased. One of these, the largest, showed a large discoloured area which might have been infected *via* the stolon, another of intermediate size was attacked in more than one place and was certainly not infected *via* the stolon, and the third was a small tuber found at a lower level than the others shewing more than one diseased area, one of which was not connected with the stolon. The diseased parts of the two larger tubers were incubated and both developed *Phytophthora* in abundance by July 12th.

Search was made on July 7th as before for any diseased shoot arising from the parent tuber of this plant or from a plant close by which might have been the source of infection of these blighted tubers, but without success. Spores may possibly have developed at some previous date on the discoloured areas already observed on plant A, but *Phytophthora* was not seen on them in the field.

The old tuber of plant A was completely rotten by this date.

Subsequent examination of the discoloured areas on the stems shewed that the fungus was confined to the cortex.

There is no doubt that plant A was affected by *Phytophthora*, but the manner in which it became infected is obscure. The possibilities are discussed later. It appears certain that the fungus developed *within the plot* and was not brought there from outside.

July 6-8. Seven other plants (Nos. 1-7) in this plot were

found to be affected in the same way as A, *i.e.*, discoloured zones appeared on the stems or petioles a little distance above soil level. Some of the portions under suspicion were removed but only the discoloured petioles developed *Phytophthora*. The fungus was not observed to fructify on these black zones in the field prior to the leaf infection noticed on July 22nd, although in the absence of continuous observation one cannot be certain that it did not. Even during an epidemic it is exceptional for the fungus to fructify on the stems in the field, and the fact that the lower petioles are often splashed with soil may have prevented the observation of fructifications on them even if present. Rain fell on July 10th, 11th, 12th, 14th, 15th, and 17th.

July 9. A plant (No. 8) shewing several small blackened areas on the branches, was dug up. The tubers were sound but there were several small discoloured zones on the stem below soil level.

July 10. A plant (No. 9) shewed blackening of the stem just above soil level. This plant was dug up on July 12th and all underground parts except the stem immediately below soil level, which was discoloured, were healthy.

July 14-17. Plants 10-27 shewed discolouration on the basal parts of the stems and lower petioles, similar to those previously described.

July 22. On this date plants (1), (2), (4), (5) and (13) were each affected by a few typical blight spots on the leaves, chiefly the lower ones. Microscopic examination confirmed the presence of *Phytophthora*. This was the first occasion on which the fungus was found producing spores in the field. The source of this leaf infection was not discovered. The blight spots rapidly increased in numbers on the leaves of these plants, and the number of discoloured areas on the stems and petioles of these plants developed considerably after the appearances of the fungus in epidemic form, although the fructifications were not seen on these particular parts in the open.

July 23. Plants (6), (11), (14), (15), (19) shewed blight spots on the leaves.

July 24. Plants (23), (24), (26) ditto.

July 25. Plants (7), (10), (20), (21), (22) ditto.

July 28. Plant (12) ditto.

Aug. 1. Plant (25) ditto.

At this date plants (3), (8), (9), (16), (17), (18) and (27) which had been under suspicion of being affected by *Phytophthora* on account of having discoloured areas towards the base of the plant

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were still free from undoubted blight spots on the leaves. Likewise all other plants in the plot except those mentioned were still unaffected by blight.

Between July 24th and 28th several small garden plots near Plot 1 in Haven Street shewed blight spots on the leaves.

The weather conditions between June 24th and Aug. 2nd were as follows;—Rain fell on July 10, 11, 12, 14, 15, 17, 22, 23, 24, 26, 27, and Aug. 2, the other days being dry and warm. It will be noted that no rain fell between June 24th and July 10th and this dry spell probably delayed the appearance of the disease in epidemic form.

There are several possible explanations of the way in which plant A became infected:—

1. The seed tuber may have thrown up a diseased shoot which escaped observation, from which spores were (a) splashed upwards by rain to infect the base of the stem and lower leaves, and (b) washed down into the soil to infect the tubers. As stated, however, there was no trace of such a diseased shoot.

2. A diseased shoot which escaped observation may have grown up from some other tuber near by, but it is more difficult in this case to understand why other plants did not shew discoloration at the same time as plant A and why the tubers of the latter should be infected.

3. The plant may have become infected by spores existing *in situ*. It might be supposed, for example, that resting spores in the soil at this spot germinated, giving rise to conidia or zoospores which may have been splashed upwards to the lower parts of the plant and also washed down to the tubers. If so, it is uncertain how such spores got into the soil as the previous crop was onions, although in view of the widespread opinion amongst practical men that potato disease is often propagated by way of the manure, it is perhaps of some significance that two years previously the site was a fowl run.

4. A blighted tuber or portion of such near the surface of the soil may have given rise directly to conidia, but in view of the previous crop, this is unlikely.

From July 22nd onwards, certain other plants in this plot already under suspicion of being affected by *Phytophthora*, became attacked by typical blight spots, chiefly, but not exclusively, on the laminae of the lower leaves and it appears likely that these were derived from spores which arose on certain of the discoloured areas noted before this date, but which escaped observation. It is of interest that, in this plot, of the plants which did not shew

discoloured areas before July 22nd, none exhibited typical blight spots, on the leaves up to the end of the period.

From an examination of the plan of the plot it is evident that there was no regularity in the sequence of the plants shewing first, suspicious symptoms, and then definite blight spots, except that the plants first affected were grouped rather towards that part of the plot which contained plant A. After the end of July the production of spores on the plot was so great that there would be no lack of material to infect the remaining plants under favourable conditions.

It is thus uncertain how the plants in Plot 1 were infected. The phenomena observed are capable of explanation either by infection *via* the soil or *via* the seed tubers.

PLOT 2.

This Plot, which was about a mile from Plot 1, contained about 60 plants of each of two varieties—Great Scot and Dunbar—and 120 of Arran Chief, all Scotch seed and planted in April. The land was under strawberries during 1917 and before being planted with potatoes was dressed with farmyard manure. On a part of the area planted with the variety Dunbar many blighted tubers of the 1917 crop had been thrown from a shed near by, in which the tubers had been sorted the previous autumn. A search in the top layer of soil revealed many decayed tubers and other tubers partly shrivelled but apparently sound, giving rise to weak shoots. Several of the latter were incubated but *Phytophthora* did not develop.

A plan of this Plot is appended:

During the period of detailed observations, none of the Great Scot plants and only two plants of Arran Chief came under suspicion of being affected by *Phytophthora*, but it was subsequently concluded that these were not so attacked.

The following record was taken of the Dunbar potatoes:—

July 9. A plant B in the area (cross shaded in the plan) containing last year's blighted tubers shewed one stem blackened all round from soil level upwards for about two inches. Two other stems of the same plant were healthy. All the neighbouring plants were sound.

July 10. No change.

July 17. No change. Another plant E in the same area shewed blackening of one of the lower petioles.

July 21 (morning). No change observed.

July 22 (evening). The plant B noted on July 9 as having a discoloured stem now shewed many petioles blackened and numerous typical blight spots on the leaves, especially the lower ones. This

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plant was dug up but all the tubers were sound and there was no discolouration of the stem below soil level.

All the other plants in this area containing last year's blighted tubers, shewed one or more leaves—especially the lower ones, attacked by *Phytophthora* on this date, but no plants outside this area, whether Dunbar or other variety, were affected. The owner picked off all the diseased leaves the same evening.

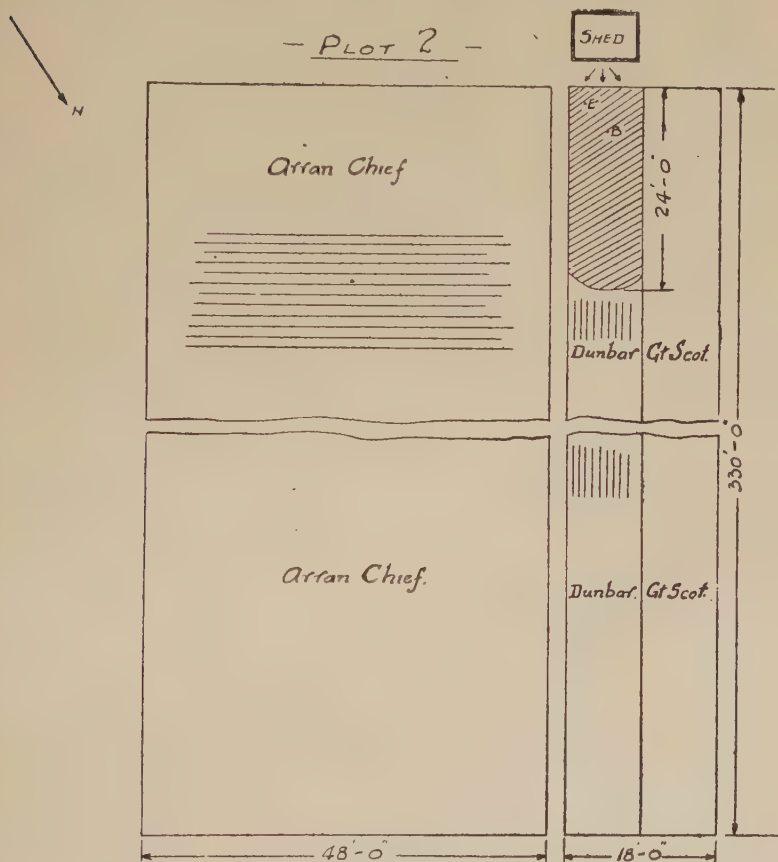


FIG. 2. Plan of Plot 2.

July 24. The same area shewed a slight increase in the number of affected leaves but these were picked off every morning. No plants were affected outside this area.

July 29. There was about twice as much leaf infection as that visible a week ago but it was still confined to the same area.

July 30. There was some increase in the amount of infection.

July 31. Some of the leaves of Great Scot plants adjoining the affected area shewed blight spots.

Aug. 2. The disease was now present on the leaves at the

far end of the Dunbar bed about 100 yards away from the area first affected.

At this date the disease was not found in any other potato areas in the immediate vicinity of Plot 2.

As in Plot 1, this outbreak of the disease in epidemic form was very circumscribed in area and was preceded by the appearance of discolouration on a stem of one of the plants in the infected area. It is noteworthy that when the fungus was first found fructifying in the field it was on this plant that it was most abundant.

Although careful search was made, no shoots from last year's blighted tubers bearing *Phytophthora* were found but strong suspicion was aroused that these blighted tubers had something to do with the outbreak, though in what way could not be ascertained.

These blighted tubers may have sent up diseased shoots bearing spores, which escaped detection, or they may have been the means of introducing resting spores into the plot. It is significant that for some time the only plants affected in the plot were those within the limits occupied by blighted tubers of the previous year. The occurrence of typical blight spots on the leaves at the same date as these were observed in Plot 1 is probably to be correlated with the incidence of similar weather conditions.

No report of the appearance of *Phytophthora* in epidemic form in other parts of the Isle of Wight was received until July 28th when it appeared at Whippingham, a few miles from Haven Street. At Whitwell, 10 miles away, I was informed that the disease was seen during the last week of July on the leaves of a single prostrate plant (Sharp's Express, an early variety) growing under very moist conditions, but blight did not become widespread there until the middle of August.

No records of the appearance of blight in the adjoining mainland counties of Dorset and Hampshire were received by the Food Production Department until the first week of August, hence it is probable that the blight fungus developed "endemically" in the Isle of Wight as regards Plots 1 and 2.

Observations in the Penzance District.

These were carried out by the writer alone and, on account of circumstances were of a more rapid nature than the observations made in the Isle of Wight. Nevertheless they are of interest. As is well known, early varieties of potatoes are grown on an extensive scale in this part of Cornwall. The soil is particularly suitable for potato growing, being a light sandy loam of good quality, and

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usually enriched with heavy dressings of farmyard manure and sea-weed. Potatoes are frequently grown on the same land year after year and as soon as the tubers are lifted in May and June, broccoli are planted. These early potatoes are grown very closely together, the rows being only about 10 inches apart and the seed sets 8 inches from one another. The plants are not earthed up as is the custom in most parts of the country. Successive visits were paid to the neighbourhood and the following is a record of the observations which are given as recorded on the spot.

May 27. At this date the lifting of early varieties had already commenced. Blight was found in a field of the variety Sharp's Express near Newlyn. The seed sets, which were obtained from Lincolnshire, had been sprouted and cut prior to planting during the third week of March. Before May 27th the weather had been dry with the exception of an occasional sea fog. In this field there were two areas on the sheltered side of a high hedge, each about a yard across, in which every plant was more or less attacked by blight in sporing condition, but in neither area could the disease be traced downwards to parts of the stems below soil level. In these two spots all parts of the plants above ground were attacked, including the flower buds, the stems often appearing to be invaded by way of the axils of the lower leaves. The fungus was fructifying on the laminæ of the leaves, but suspected discoloured portions of petioles and stems also developed *Phytophthora* spores after incubation. In addition to these two areas, there were a few scattered spots of blight on the upper leaves in other parts of this and other fields close at hand. These had presumably arisen by secondary infection, probably from spores found in the two areas referred to. As regards this particular place there could be no doubt that blight first developed in these two well defined spots in the field.

May 31. The same field was visited again. Blight had spread very little since the last visit, the weather having been dry. Another centre of infection was found, however, every plant within a circular zone two yards across being attacked, especially in the lower leaves and the parts of the stem just above soil level. As before, the disease could not be traced downwards to parts of the stems below soil level.

Two other centres of infection were found in two other fields in the same locality showing the same appearances as already described. In one of these the site was relatively dry, being situated on a slope with a southerly aspect.

Many other fields of early potatoes in this vicinity were found to be free from blight.

A centre of infection—about 3 yards across, was found in a large plot of Sharp's Express in a low-lying situation in Penzance, shewing the same symptoms as noted previously. At the margin of the infected area there were a few spots of blight on the upper leaves, but beyond these all plants were healthy.

At Madron a group of Royal Jersey potatoes—about 3 yards across, was affected by blight in the midst of a large plot of this variety. The symptoms were the same as before, but in this case opportunity was afforded of lifting some of the plants, with the result that a few tubers were found already affected by blight, *Phytophthora* subsequently developing on slices of these diseased tubers kept in Petri dishes. In these tubers the disease had not entered *via* the stolons. They may have been infected by spores which had fallen from the aerial parts, or by the fungus present in some form *in situ* in the soil. One of the upper leaflets of a plant about fifty yards away from the centre of infection was blighted, but otherwise the remaining plants were healthy. At this date neighbouring fields of early varieties were quite unaffected by blight.

June 2. One patch of blight, about three yards across, was found in a field of Sharp's Express at Gulval, the disease being chiefly present on the lower parts of the stems and the lower leaves, with typical blight spots on the latter. The disease could not be traced downwards to parts of the stems below soil level.

A group of the second early variety—British Queen—about three yards in diameter was affected in the middle of about four rods of this variety at Penzance. The symptoms and distribution of the disease were the same as before. On the circumference of the affected group, blight spots were found only on the upper leaves but in the centre of the disease area, the lower parts of the stem, the petioles, and midribs of the lower leaves were chiefly affected. Here again the disease could not be traced from above soil level to the parts of the stems below the soil. Some of the diseased plants were lifted and blighted tubers were found, but these were only exceptionally affected at the heel end, thus showing that in most cases at any rate the disease did not enter *via* the stolons. *Phytophthora* subsequently developed on these tubers after incubation.

June 23. The area last mentioned was again visited but there had been only a slight extension of blight since June 2, the weather having been dry in the meantime, but on a neighbouring plot there were a few blight spots on the upper leaves and also on a main crop

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variety growing partly under trees about fifty yards away. By this date nearly all early varieties had been dug in this district.

Numbers of other potato areas were examined in the vicinity of Penzance at this time with negative results, and it is noteworthy that up to June 23rd not a trace of blight was found on varieties of potatoes other than earlies and second-earlies. The weather remained dry until about the middle of July and there was no appreciable development of blight on main crop potatoes in the western parts of Cornwall until the end of that month. Of course had wet intervened when the early varieties were first affected the disease would have spread with its usual rapidity.

Conclusions.

The observations taken in the Penzance district agree in kind with those made in the Isle of Wight and shew with the latter that the earliest outbreaks of blight developing *in situ* are of strictly limited extent and that from them the fungus develops centrifugally under favourable conditions until the spores are so widely distributed in the air that infection of susceptible plants becomes universal. The observation that blight affects the tubers at a very early stage in the development of the disease is noteworthy, as is also the evidence presented that these do not generally become infected from the main stem *via* the stolons. The facts observed are capable of interpretation either by infection from the soil through the agency of some form of resting body or by infection from blighted shoots growing upwards from diseased sets. The latter were not found in spite of careful search, although it is known that they have occasionally functioned under experimental conditions. The fact that the first plants to be affected are in limited groups may at first thought appear to invalidate the possibility of infection from the soil, but it does not follow that resting bodies, if formed, would be regularly distributed in the soil and it is likely that only a few would function and be successful in causing blight to develop on the plants. One is reluctant to give up the idea of some form of resting body in the life-history of this fungus in nature, for it would be suprising if this fungus, which can produce oospores in artificial culture, were unable to form these in nature under certain, at present unknown, conditions.

These observations shew that it will be a matter of difficulty, and perhaps also of considerable luck, to obtain critical evidence as to the mode in which the blight fungus is carried over from year to

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year in crops of potatoes grown under ordinary conditions. In shewing that the first attacks are strictly limited where extraneous infection is not operative, the solution of the problem is advanced slightly, and by continued attack along these and other lines the obscurity which still exists in regard to the life-history of *Phytophthora infestans* in the field should be removed.

In conclusion, the grateful thanks of the observers and the writer are due to all those in the Isle of Wight and in the Penzance district who provided facilities for carrying out these observations, especially to Mr. C. Martin, Instructor in Horticulture for the Isle of Wight, and also to Professor Oliver, F.R.S. for his great interest and help throughout the work in the Isle of Wight.



THE NEW PHYTOLOGIST.

A BRITISH BOTANICAL JOURNAL,

EDITED BY A. G. TANSLEY, M.A., F.R.S.,

UNIVERSITY LECTURER IN BOTANY, CAMBRIDGE.

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Vols. 1, 3, 6, 7, 10, 11 and 12 are out of print. Vols. 2, 4, 5, 8, 9, 13-17, 15s. each.

Published by MESSRS. WM. WESLEY & SON, 28, Essex Street London, W.C., to whom all subscriptions and business communications are to be addressed.

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